

Code: A-04

JUNE 2006

Subject: MATERIALS AND PROCESSES

Time: 3 Hours

Max. Marks: 100

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x10)

a. Metallic bond is not characterised by

- (A) ductility. (B) high conductivity.
(C) directionality. (D) opacity.

b. Zinc has hcp structure. In a unit cell of zinc, the zinc atoms occupy

- (A) 74% of volume of unit cell. (B) 80% of volume of unit cell.
(C) 68% of volume of unit cell. (D) 90% of volume of unit cell.

c. Piezoelectric effect is the production of electricity by

- (A) chemical effect. (B) varying magnetic field.
(C) temperature. (D) pressure.

d. The density of carriers in a pure semiconductor is proportional to

- (A) $\exp\{-E_g/kT\}$ (B) $\exp\{-2E_g/kT\}$
(C) $\exp\{-E_g/kT^2\}$ (D) $\exp\{-E_g/2kT\}$

e. The probability of occupation of an energy level E , when $E - E_F = kT$, is given by

Q.2 a. Describe the salient features of ionic and covalent bonded crystals with two suitable examples for each of them. (6+2)

b. Show that the atomic packing factor for FCC and HCP metals are the same. Draw (112) and (120) planes in a fcc structure. (6+2)

Q.3 a. Describe with suitable diagrams the edge dislocations and screw dislocations in crystal lattice. What is a Burgers's vector? (6+2)

b. Explain with suitable diagrams the lever rule and Tie-line rule. Why there are tie lines for 3 phase equilibrium but not for 2-phase equilibrium in a two-component system? (6+2)

Q.4 a. What are the main sources of electrical resistance in a metal? Discuss the effect of impurity, temperature and alloying on the electrical conductivity of metal. (4+6)

b. Explain why nichrome and not copper is used as a heating element where as manganin is used as standard resistance. (6)

Q.5 a. Distinguish between intrinsic and extrinsic semiconductor. Obtain an expression for the carrier concentration for an intrinsic semi-conductor. Also show that the fermi level in an intrinsic semiconductor lies approximately half way between the top of valence band and the bottom of conduction band. (2+8+2)

b. In a semiconductor the effective mass of an electron is $0.07m_0$ and that of a hole is $0.4 m_0$, where m_0 is the free electron mass. Assuming that the average relaxation time for the holes is half that for the electrons, calculate the mobility of the holes when the mobility of the electrons is $0.8 \text{ m}^2 \text{ volt}^{-1} \text{ sec}^{-1}$. (4)

Q.6 a. Explain the term 'depletion layer' across a p-n junction. How does a p-n junction function as a rectifier? Explain qualitatively. (2+6)

b. What is piezoelectricity? What are different applications in which piezoelectricity is used. Describe materials that show piezoelectricity. (2+6)

Q.7 a. How does B-H hysteresis curve be understood interms of domain growth and domain rotation? Explain how a high initial permeability in Fe-Ni alloys helps to reduce the area under the hysteresis loop. (5+5)

b. Distinguish ferromagnetic, ferromagnetic and anti-ferromagnetic materials. Give an example of each class of material. Discuss the various uses of ferrites. (6)

Q.8 a. What are the objectives of heat treatment of metals? What precautions are necessary while heat-treating to avoid defects? What are the effects of tempering on the mechanical properties of steel? (3+3+3)

b. In what manner hot worked and cold worked products differ? Describe the hot and cold forging. Compare their properties and economics. (3+4)

Q.9 Write short accounts on the following processes:-

- (i) Oxidation in processing of electronic materials.
- (ii) Epitaxial growth (CVD).
- (iii) Ion implantation.
- (iv) Soldering and brazing. (4x4)